Examiners' Report
Principal Examiner Feedback

October 2023

Pearson Edexcel International Advanced Level In Pure Mathematics (WMA12) Paper 01

General Introduction

The October 2023 WMA12 paper had a variety of very accessible and familiar questions such as 1, 4, 7, and 8 as well as ones that tested the high achieving candidate. Questions 2b, 3, 6, 9 and 10 proved to be very discriminating. The paper was of an appropriate length with little evidence of students rushing to complete the paper.

Points to note for centres

- Candidates often divide out factors rather than factorise equations and hence miss some solutions, as was witnessed in 3a
- Candidates should take care when reading a question. For example, in question 10(i) many found the terms in x^2, x^3 and x^5 rather than the second, third and fifth terms of the expansion. Also, in question 4c, many candidates did not **fully** factorise their expression.
- Candidates need to be careful to show all the steps in "show that" questions. This was not only true in question 7a but also in questions 4c, 8b and 10iia.

Question 1: Proof by exhaustion

This was a familiar context for a question and many candidates scored full marks. The solution merely required the sight of three correct rows and a minimal conclusion. Reasons for a loss of marks were:

- the addition of extra rows
- the omission of a conclusion
- an attempt at an algebraic solution which proved more demanding than that of a numerical one
- a mix up between columns *b* and *c*

Question 2: Iterative sequence and sum

Part (a) of this question was straight forward for most candidates with the majority scoring full marks. Unfortunately, for many, this was the only 3 marks they scored in the question. Part (b) was found to be surprisingly difficult for many with lots of incorrect solutions. These incorrect solutions included:

- attempts at the sum to 100 terms of geometric or arithmetic series
- attempts at $\frac{100}{3}\left\{3+\frac{2}{3}+-4\right\}$
- attempts at $100\times\left\{3+\frac{2}{3}+-4\right\}$

Question 3: Trigonometric Equation

The majority of candidates scored the first mark in this question for using the identity $\tan\theta = \frac{\sin\theta}{\cos\theta}$ Multiplying by $\cos\theta$ and factorising should have then led to the equation $\sin\theta(2+3\cos\theta)=0$. Many however cancelled the $\sin\theta$ and hence only produced solutions from $\cos\theta = -\frac{2}{3}$. There were some long winded attempts via the use of the Pythagorean identity $\sin^2\theta+\cos^2\theta=1$ that could result in a correct solution, but many of these resulted in incorrect or additional answers.

For those who did make good progress in part (a), many then set their smallest solution to $2x+40°$ and solved for x. It was important that only one value was offered here.

Common errors seen were:

- solving $\cos\theta = +\frac{2}{3}$ rather than $\cos\theta = -\frac{2}{3}$
- multiplying the initial equation by extra factors of $\sin\theta$ or $\cos\theta$ producing much more demanding equations
- giving all solutions to part (b), not the smallest as required by the question.

Question 4: Factor and Remainder Theorem

Part (a) was a proof with the result $a+4b=-56$ given on the question paper. It is very important in questions like these to show all steps in the solution, in this case starting by setting $\mathrm{f}\left(-\frac{1}{2}\right)=0$. A correct intermediate step of $\frac{1}{4}a+b+14=0$ should have then led to the given result.

Part (b) involved using the remainder theorem to set $\mathrm{f}(2)=-25$ leading to a second equation in *a* and *b*.

In part (c) the simultaneous equations could then be solved and the resulting expression for f (*x*) factorised. Using part (a) candidates should have been aware that $(2x+1)$ was a factor and by division, or otherwise, the quadratic factor found. Hence it was possible to use all the information in the question to fully factorise f (*x*), writing it as a product of 3 linear factors.

Common errors seen in this question included:

- setting $\mathrm{f}\left(\frac{1}{2}\right)=0$ in part (a) and /or setting $\mathrm{f}(-2)=-25$ in part (b)
- not showing the = 0 or intermediate lines when attempting to prove (a)
- leaving the answer to (c) as $(2x+1)(2x^2+x-15)$
- using a calculator to **solve** $4x^3+4x^2-29x-15=0$ and writing $x=-3, -\frac{1}{2}, \frac{5}{2}$

Question 5: Logarithms

Part (i) was well done by the vast majority of candidates with almost all showing the correct intermediate line that was necessary to score both marks.

Part (ii) discriminated more, with many scoring only the first mark. Combining two terms proved demanding for many and choosing only the positive solution $b = \frac{\sqrt{5}}{9}$ equally discriminating.

Common reasons for the loss of marks were:

- truncating solutions in part (a) to 3.87 when the demand was to 3 decimal places
- omitting the 3 in $3\log_3 b$ or else writing $3\log_3 b$ as $\log_3 b^2$
- writing the 4 as $\log_3 64$ rather than $\log_3 81$
- failure to discard the negative and 0 solution in (ii)

Question 6 Trapezium rule

Unusually this question on the trapezium rule was set in a "real life" context. This caused many candidates to stop and think and it proved too demanding for others. Most knew how to tackle part (a) but found extracting information from a graph much harder than extracting it from a table. The 0's at each end of the graph caused additional problems. Using their answer from part (a) to find the volume of water passing through the cross section each minute was also discriminating. Part (c) was perhaps found to be the most difficult mark for candidates to achieve. Stating that the answer to part (a) is an underestimate because it is less than the true area is not giving a reason as to why it is less. It was important for candidates to allude to the fact that the sum of the areas of trapezia found in part (a) was less than the shaded area, hence it is an underestimate.

Question 7: Circle rules and formulae

Part (a) involved using the perpendicular rule linking a tangent and a radius. Most candidates were aware of this and the need to use the point $(4, -3)$. It was a proof question however, and many did not pay heed to the fact that all intermediate steps should be shown. In part (b) the equation of the circle was required to be found. Many candidates were aware of the process and many candidates generally went on to accurately find it. Unfortunately, there were others who made algebraic slips when solving the simultaneous equations with more failing to find the value of the radius. The question was a good source of marks for the careful and well-prepared candidate.

Question 8: Arithmetic Sequences

This was the second context question on the paper. It was handled extremely well by candidates who used the correct formula for the appropriate part of the question. As a result, many candidates scored most of the marks for this question.

Common reasons for a loss of marks were:

- use in part (a) of the term formula $a+(n-1)d$
- use of an incorrect sum formula $S_n = \frac{n}{2}\{a+(n-1)d\}$ throughout the question
- writing down both 29 and -37 for the answer to (c)(i)
- not realising that in an increasing arithmetic sequence, the greatest term is the last one. Many candidates used differentiation or other similar methods in (c)(ii)

Question 9: Calculus

This question discriminated particularly well, especially for high achieving candidates.

In part (a), differentiation was required to ascertain where the function was increasing. Whilst most candidates were aware of this some found the challenge of both differentiation and solving the ensuing equation too demanding.

Part (b) was an 8-mark problem solving question involving both differentiation and integration. It is really important in such a question to clearly set out a strategy. The easiest and most direct route was to find the area under the curve between 0 and 9 and then subtract the area of a triangle. Only careful and logical-thinking candidates were aware of the process needed to find the appropriate lengths required to find the area of the triangle. Many candidates scored the first 3 marks for finding the area under the curve between 0 and 9. It was pleasing to see that almost everyone heeded the warning and did not use the definite integration facility of their calculators to produce this answer. The next 3 marks were scored for finding the point at which the tangent to the curve cut the *x*-axis. This was where high achieving candidates shone and those less well prepared struggled. The final two marks could only be scored by candidates with a fully formed strategy and were scored by the best candidates on this paper.

Question 10: Series, Binomial and Geometric

The last question on the paper also proved to be discriminating, especially parts (i) (b) and (ii) (b).

As in question 9, high achieving candidates scored heavily whilst less prepared candidates struggled with the demand.

In (i) (a) most candidates made progress. Using the binomial expansion to expand $(3+2x)^6$ is usually a well-rehearsed skill on WMA12 and aspects of it proved relatively straightforward this time. Unfortunately, what candidates struggled with, was picking out the 2nd, 3rd and 5th terms. This was unexpected, with many candidates just writing out the whole expansion or else finding the terms in x^2, x^3 and x^5. As a result, many could not set up an appropriate equation in (i) (b) and many omitted due to the demand. Pleasingly there were some very well constructed solutions.

In (ii)(a) many candidates were able to use the correct formula to set up a correct equation in θ. Using $\sin^2\theta = 1-\cos^2\theta$ within this equation could convert this to an equation in just $\cos\theta$. Almost all candidates who got this far went on to score all 3 marks. Few candidates lost marks for poor/incorrect notation this series. The last part of the question demanded high problem-solving skills by candidates and a good proportion were up to the task. After finding the value of $\cos\theta$, substituting this into the expression $2\sin^2\theta\cos\theta \equiv 2\left(1-\cos^2\theta\right)\cos\theta$ found the value of the second term.

Common reasons for a loss of marks in this question from candidates who made did some progress were:

- a misunderstanding of which are terms 2, 3 and 5 in the binomial series
- a lack of understanding that if *a*, *b* and c are consecutive terms of a geometric sequence then $\frac{b}{a} = \frac{c}{b}$ or $b^2 = ac$
- given $\cos\theta = \frac{1}{5}$ the exact value of $\sin^2\theta$ is $\left(1-\cos^2\theta\right) = \frac{24}{25}$
- proceeding to an answer for (ii)(b) via inexact routes, e.g. via θ =78.46°